Research Article Journal of Orthoptera Research 2026, 35(1): 215–232

Grasshopper community structure and the rising dominance of generalist species across vegetation types in a biodiversity hotspot

Charly Oumarou Ngoute[1], Idriss D. Kouahou Chekep[1], Obrix R. Ngameni Tchatak[1], Manfred Nohen Mam[1], Giresse F. Kameni[1], Alain Simeu Noutchom[2], Ester N. Otiobo Atibita[1], Alain D. Missoup[1], Jean A. Mbida Mbida[1], Maurice Tindo[1], Patrick Akono Ntonga[1], Leopold G. Lehman[1]

1 Department of Biology of Animal Organisms, Faculty of Science, University of Douala, Douala, Cameroon.
2 Department of Animal Biology and Physiology, Faculty of Science, University of Yaoundé 1, Yaoundé, Cameroon.

Corresponding author: Charly Oumarou Ngoute (coumaroungoute@yahoo.fr)

Academic editor: Michel Lecoq | Received 17 November 2025 | Accepted 2 March 2026 | Published 6 April 2026

https://zoobank.org/FB2D351A-D187-48DD-8453-22083D072D1D

Citation: Oumarou Ngoute C, Kouahou Chekep ID, Ngameni Tchatak OR, Nohen Mam M, Kameni GF, Simeu Noutchom A, Otiobo Atibita EN, Missoup AD, Mbida Mbida JA, Tindo M, Akono Ntonga P, Lehman LG (2026) Grasshopper community structure and the rising dominance of generalist species across vegetation types in a biodiversity hotspot. Journal of Orthoptera Research 35(1): 215–232. https://doi.org/10.3897/jor.35.178306

Abstract

Grasshoppers are one of the most dominant and diversified groups in terrestrial ecosystems, of which they are potential bioindicators. In West-Central Africa and the Congo basin, the Acridomorpha fauna is dominated by Acrididae, Pyrgomorphidae, Thericleidae, and Ixalidiidae. This biodiversity is still understudied. The current study compared the grasshopper communities of four vegetation types in the Bangou district: crop field, fallowland, forest, and bare soil. Grasshoppers were sampled using sweep netting and identified in the laboratory using appropriate keys. The species composition was analyzed using several statistical indices: species richness, abundance and abundance distribution model, frequency of occurrence, diversity and similarity, SIMPER, and IndVal. A total of 48 species and 10 subfamilies from three families—Acrididae, Thericleidae, and Pyrgomorphidae—were recorded. Crop field and fallowland hosted the highest grasshopper richness and abundance, while forest and bare soil showed few taxa. *Chrotogonus homalodemus* served as a specialist or bioindicator of bare soil, whereas four species—*Parapterotiltus minimoides*, *Pterotiltus coeruleocephalus*, *Parepistaurus* sp., and *Thericles* sp.—indicated forest land. Polyculture enhances plant-resource diversity and expands ecological niches, allowing most generalist species to occur while only a few become rare or highly dominant. Overall, both the number and proportion of generalist species increased markedly with land-use intensification, while rare species occurred in lower proportions in the most disturbed habitats. In the Bangou district, habitat disturbance has increased pest activities of some taxa such as *Eyprepocnemis plorans* or *Catantops melanostictus*, whereas other threatened species (e.g., *Parapetasia rammei* and *P. minimoides*) were confined to the remaining forest patches, emphasizing the need for sustainable land management.

Keywords

Acridomorpha, Bangou district, landscape, land use, species composition, West Cameroon

Introduction

Biodiversity is the diversity of living organisms on Earth, including plants, animals, microorganisms, their genomes, and the ecosystems they inhabit. Halting the biodiversity crisis is one of the major challenges for human society. The importance of biodiversity is recognized worldwide. Some organisms provide food, while others serve as ecosystem health indicators or offer therapeutic benefits (Chandrakar and Dhuria 2019). Furthermore, biodiversity conservation has become a cornerstone, a basic objective, and a collective responsibility for biologists. The goal of bioindicator research is to find species that can reliably detect environmental disturbances and to demonstrate how those disturbances affect other species or biodiversity as a whole (Chowdhury et al. 2023). Human-induced environmental changes cause profound disruptions in natural populations. The rare species, previously undisturbed in their natural habitat, may then be found over large areas where ecological conditions have become favorable to their proliferation. Some species—the most competitive ones—that adapt to newly created habitats continue to thrive there, whereas other less tolerant species move away from transformed and hostile environments toward more suitable areas, thereby shifting their habitat range. Species associated with high plant diversity may decline or even disappear as the plant diversity of the environment decreases (Midgley et al. 2003, Latchininsky et al. 2011, Adu-Acheampong 2017). Endemic species, particularly wingless ones, are generally the most negatively affected by environmental disturbances.

Insects are particularly valuable for assessing the impact of human activities on terrestrial ecosystems. They make up a substantial portion of Earth's biological diversity and often serve as hosts for numerous other organisms, including parasites, mutualists,

Copyright *Charly Oumarou Ngoute et al.* This is an open access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

and commensals (Larsen et al. 2017, Li and Wiens 2023). Among insects, grasshoppers are a dominant invertebrate group in terrestrial ecosystems in which they are potential bioindicators (Oumarou-Ngoute et al. 2023).

Grasshoppers are a large group within Orthoptera. They belong to the suborder Caelifera, which contains 12 families and over 1,700 genera (Cigliano et al. 2025). Acridomorpha are integral to terrestrial ecosystems and are characterized by elevated degrees of endemism (Yetchom-Fondjo et al. 2020). These insects are an important link in food chains because they are consumed by other organisms, such as birds, reptiles, amphibians, mammals, and other arthropods (Leksono et al. 2020, Oumarou Ngoute et al. 2021). From a nutritional point of view, grasshoppers are among the most important edible insects worldwide and are increasingly being incorporated into Western diets through various derived food products (Paul et al. 2016, Haldar and Malakar 2017, Magara et al. 2025). Moreover, grasshoppers are important ecosystem components, and several taxa are often used for environmental biomonitoring purposes (da Silva et al. 2021).

The ecological importance of these insects as bioindicators for land management and climate change has been highlighted in different parts of the world (Uchida and Ushimaru 2014, Poniatowski et al. 2020, Manna et al. 2020, Sergeev 2021, da Silva et al. 2021, Fartmann et al. 2022, Mariottini et al. 2024). Some authors have found that the richness and abundance of grasshopper species increase with habitat disturbance, except for species with low dispersal ability (Latchininsky 2008, Fartmann et al. 2022). Others have stated that the diversity of these insects decreases in open environments after perturbation (Hao and Wang 2015, Soliman et al. 2017, Mariottini et al. 2024), while others have reported that land use variation does not significantly affect the abundance, species richness, and diversity of grasshoppers (Leksono et al. 2020).

In general, the results of these studies have shown that grasshoppers can be classified into habitat generalists and specialists (Nakajima and Miyashita 2021). The Grinnellian specialist species are organisms whose niches are narrowly defined by specific abiotic conditions (such as climate, altitude, or substrate) rather than by biotic interactions. They show limited adaptability, are often confined to very specific habitats, and are therefore highly vulnerable to environmental change, whereas generalists tolerate a wider range of conditions within an ecosystem (Richmond et al. 2005, Dehling et al. 2021). Comparing the proportions of specialist and generalist species, as well as rare taxa, helps diagnose habitat conditions, assess the impacts of disturbance, and guide conservation strategies by identifying the most vulnerable or ecologically stable areas.

The grasshopper diversity in West-Central Africa and the Congo basin is still understudied. Research on the responses of grasshoppers to environmental disruption is lacking despite the high level of deforestation observed (Oumarou-Ngoute 2024). In Cameroon, few recent studies have been conducted to clarify the effect of land use on grasshopper fauna, and these studies are fragmented, focusing on parts of the highland areas (Kekeunou et al. 2017, Wandji et al. 2019), lowland areas in the coastal region (Yetchom-Fondjo et al. 2020), or in the South Cameroon plateau (Oumarou Ngoute et al. 2020, 2023). In southern Cameroon rainforest areas, forest clearing creates a suitable environment for the proliferation of pest grasshopper species, with the consequences of increased pest activities in crop fields and disruption of the ecosystem's balance (Oumarou-Ngoute et al. 2023). The status of the highland areas of the country still needs to be clarified. The Bangou area is a transitional zone bridging the low altitude of southern Cameroon and the peaks of the volcanic line. Thus, studying acridids in Bangou is an important step in understanding grasshopper distribution and diversity in Cameroon.

In this study, the following questions were addressed: How does the grasshopper community structure observed at Bangou compare with that of similar habitats elsewhere in Cameroon when such data exist? To what extent does grasshopper community composition vary among the four habitat types? Are there significant differences in the proportion of habitat generalist species across habitats? We hypothesized that Bangou has high and endemic grasshopper biodiversity compared to other similar habitats in Cameroon because it is part of the Cameroon Volcanic Line, which is known for its high levels of biodiversity and endemism, that the grasshopper community differs significantly among the four habitat types with each habitat hosting a distinct assemblage of species, and that the proportion of habitat generalist taxa varies across ecological zones, with more generalists occurring in disturbed areas (such as fallowland and crop fields) than in forests.

Material and Methods

Study site.—Grasshoppers were sampled monthly from January to December 2024 across four habitat types (crop fields, fallow lands, forest, and bare soil) at 24 sites in the Bangou district (1500 m a.s.l.; 5°14'12"N, 10°24'21"E), Hauts Plateaux Division, West Cameroon (Fig. 1). The region's vegetation consists mainly of semi-deciduous forest and savannah, with remnants of evergreen forest in wetlands and mountainous areas (Brénac 1988, Tiokeng et al. 2020). These ecosystems are now heavily disturbed, and original plant species persist only in relics of "sacred forests," in inaccessible areas, or along waterways (Tiokeng et al. 2020). The original vegetation is almost completely replaced by mixed crop fields (Nkongho et al. 2024). Mixed cropping involves planting multiple crops, such as corns, beans, plantains, groundnuts, legumes, and tubers in the same field to maximize the yield, improve soil health, enhance food security, and manage land scarcity (Jacobsen et al. 2004, Nkongho et al. 2024).

The climate in West Cameroon is of a sub-equatorial type with two seasons: a dry season (from November to March) and a rainy one (from April to October). Annual rainfall ranges from 1,500 mm to 2,000 mm per year with an average temperature of 22 °C (Santoir and Bopda 1995). Soil is reddish and lateritic, with a fertile top layer (Muller 1974). In this work, the studied forests were relics of degraded patches consisting of a few trees (e.g., *Ficus* sp. and *Ceiba pentandra*) along with raffia palms (*Raphia vinifera*) used for construction (raffia bamboo), crafts (fiber products), and beverages (fermented sap–raffia wine). The forest undergrowth was mainly composed of plant species from the Euphorbiaceae, Moraceae, Rubiaceae, Malvaceae, and Sapotaceae families (Tiokeng et al. 2020). Crop fields consisted of mixed plantings of corn, beans, plantains, and groundnuts. Fallowlands were short-term and dominated by herbaceous (grass) species of genera, such as *Panicum*, *Cymbopogon*, and *Pennisetum*, often associated with bushfires and grazing by local communities. Bare soils were reddish and lateritic, with no vegetation cover.

Grasshopper sampling and identification.—Grasshoppers were sampled monthly over a 12-month period (January 2024 to December 2024) in each of the four vegetation types studied. Sampling was conducted in the daytime using sweep netting randomly within each vegetation type for a 120-min period. During the sampling time, researchers walked through habitats and actively flushed grasshoppers using a sweep net consisting of a wooden frame

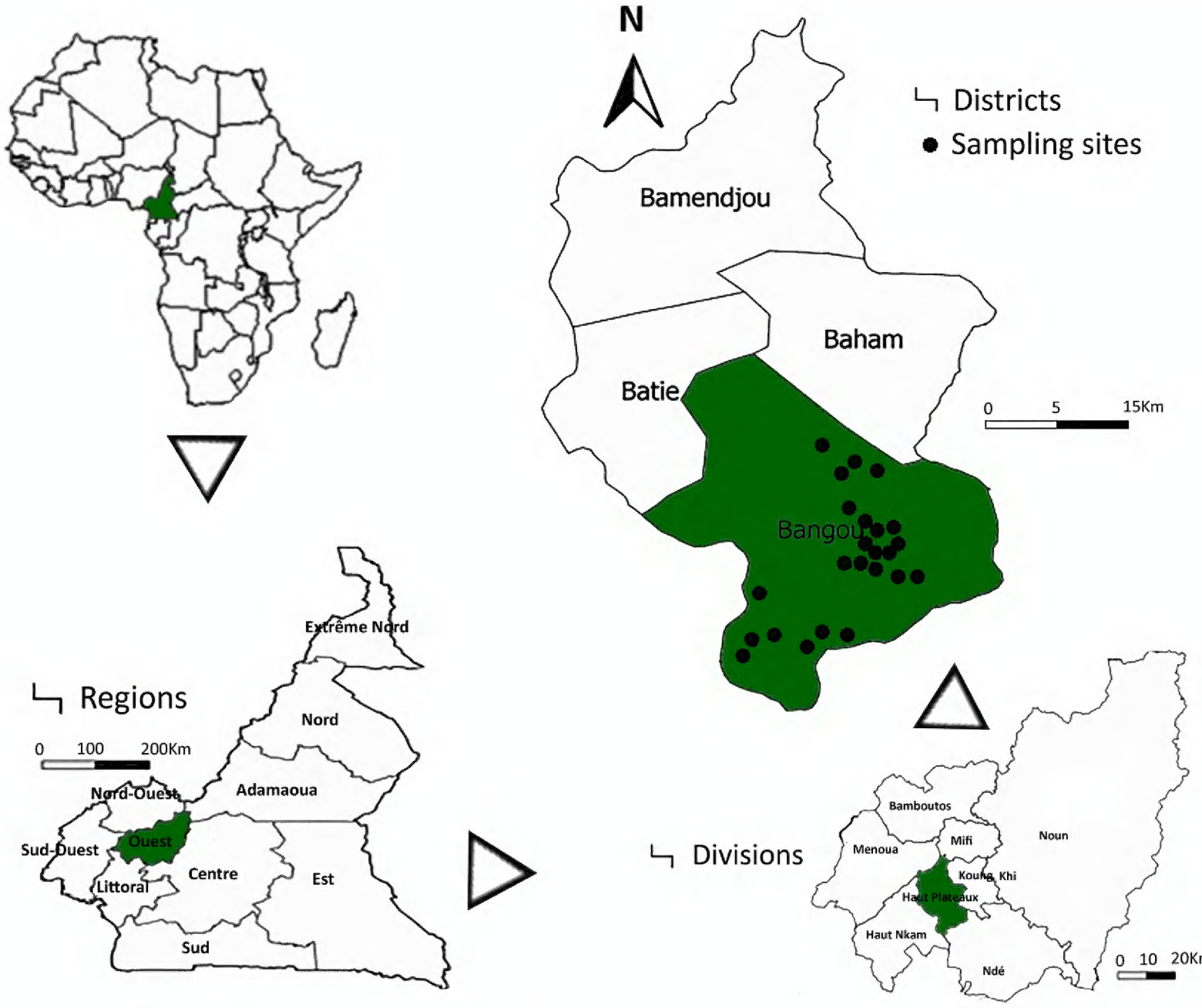

Fig. 1. Sampling sites of grasshoppers in Bangou district, West-Cameroon.

(1.2 m in length, 50 cm in diameter). Grasshopper detection relied on visual observation throughout the sampling period. All collections began from a fixed point and extended across the entire site. Collected grasshoppers were placed in pre-labeled boxes. The collected specimens were photographed in the field and transported to the Zoology Laboratory of the University of Douala for identification at the species level through external morphology and/or genitalia structure. The identification was made using keys from the following: Dirsh (1958, 1965, 1970), Keith and Kevan (1974, 1969), Hollis (1975), Karsch (1891), Ramme (1929), Jago (1984, 1994a, b), Grunshaw (1991), Rowell et al. (2015), Rowell and Hemp (2017, 2018), Mariño-Pérez and Song (2023), Oumarou-Ngoute and Rowell (2024), and Rowell and Oumarou-Ngoute (2025).

Data analysis

Species richness and sampling effort.—We calculated grasshopper species richness (Taxa S) in the different habitat types as the total number of species of the supra-specific taxa (Dajoz 1982). The theoretical values of the species richness were estimated using the Chao 1 estimator, and then individual rarefaction curves (Fig. 2) were generated using PAST software, version 4.17 (Marcon 2018, Hammer 2024). Sampling effort was calculated as the ratio of the observed species richness to the theoretical species richness (Appendix 1: Table A1).

Abundance and abundance distribution model.—The absolute and relative abundances (Marcon 2018) of the grasshopper species were calculated using Excel software, version 2016. The species relative abundance (fx) for each of the studied habitat types was calculated as the ratio of the sum of abundances of a species over the sum of abundances of all the species from the vegetation types, as follows:

$$fx = \frac{\sum x1 + x2 + x3 \ldots + x12}{N} \times 100$$

where $\Sigma x_1+x_2+x_3...+x_{12}$ is the sum of the abundances of species x from the first to the twelfth month of sampling in a given habitat, and N is the sum of the abundances of all species across the four habitat types. The species' relative abundance per habitat was also expressed for each sampling event/month. We categorized the values of the relative abundance (fs) according to Dajoz (1982): fs > 50% = very abundant taxa; 25% ≤ fs ≤ 50% = abundant taxa; 1% ≤ fs < 25% = less abundant taxa; fs < 1% = rare taxa. The mean relative abundance is represented in Fig. 7, with the mean value depicted by a bar and the whisker intervals indicated as a one-sigma range (Hammer 2024). Comparisons of the relative abundances were conducted using the Kruskal-Wallis (H) test and the Mann-Whitney (W) test for pairwise. The abundance distribution model provides data on the use of the available resources in the studied vegetation type by the different grasshopper species (Havyarimana et al. 2013). Using the R 4.4.0. software, we compared the observed grasshopper abundance distribution in the different vegetation types studied to the theoretical distribution models of Fisher (log-series model), Mac-Arthur (broken stick model), Motomura (geometric model), and Preston (log-normal model) (Marcon 2018) using the chi-squared test.

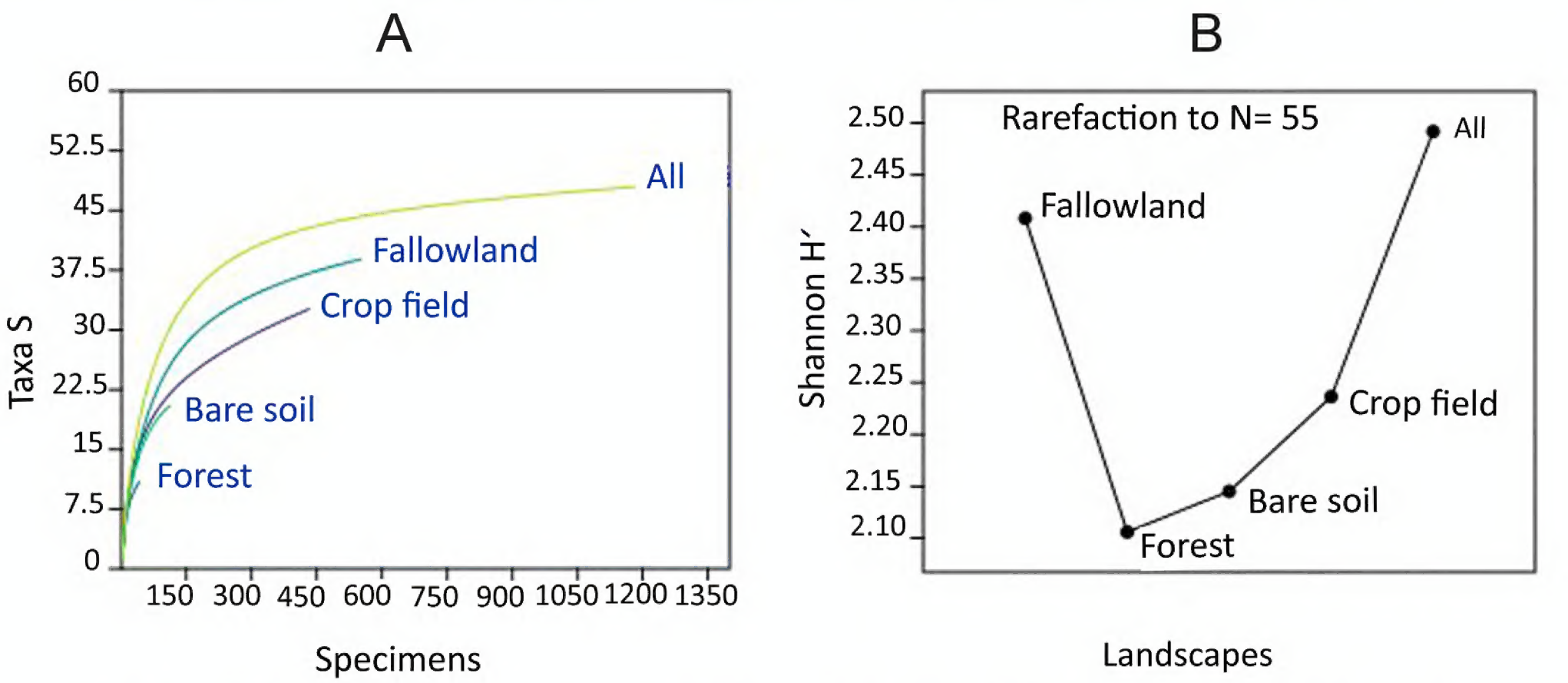

Fig. 2. Individual and Shannon rarefaction curves in the studied vegetation types. **A.** Individual rarefaction curves; **B.** Shannon rarefaction curves. Taxa S: the values of the grasshopper species richness; Shannon H′: the values of the Shannon (H′) diversity index.

The log-normal model assumes a relatively balanced distribution of available resources within a habitat where species abundances are moderate and evenly distributed; the log-series model indicates a heavily disturbed ecosystem, characterized by intense interspecific competition for resources and dominated by rare species; the broken-stick model reflects minimal interactions between species in a habitat where ecological resources are shared randomly; and the geometric model represents a hierarchical use of resources in a community dominated by pioneer species where each species exploits a constant proportion of the remaining resources (Fattorini et al. 2016, Marcon 2018, Zang et al. 2022).

Frequency of occurrence.—The frequency of occurrence (*fo*) provides the occupation of the available space by the studied taxa. We express the occurrences in Appendix 1: Table A1, as the ratio of the number of samples in which a species was present over the total number of samples realized. Analysis was performed using the PAST software. We categorized (*fo*) as Dajoz (1982): *fo* > 50% = constant taxa; 25% ≤ *fo* ≤ 50% = accessory taxa; *fo* < 25% = accidental taxa. Distribution of the grasshopper frequency of occurrence per habitat in Fig. 10, was visualized using box and jitter plots. These plots depict the quartiles as a box with a median as a horizontal line inside the box. Quartile calculations were performed using interpolation methods (Hammer 2024). Data points falling outside the inner fences are displayed as circles in Fig. 10, while those exceeding three times the box height, known as the "outer fences", are marked with stars. Comparisons of the frequency distributions were made using the Kruskal-Wallis (H) test, while the pairwise comparison was performed using the Mann-Whitney test.

Diversity and similarity.—The diversity indexes expressed the degree of complexity of the grasshopper species assemblages in an ecosystem or habitat. The Shannon (H′) index (Carlo et al. 1998) was used in PAST 4.17 to express and compare the grasshopper diversity of the different habitat types. Principal component analysis (PCA) of the species communities was generated using the same software. In the PCA, the first two components were the main axes of variation that best distinguish the habitats and species studied. Component 1 (PC1) captures the largest proportion of variation in the abundance data, whereas component 2 captures the second-largest proportion of variation and is independent of PC1. The software automatically calculated (from abundance data) the Euclidean distances between species and habitat types (Hammer 2024).

Species status.—To assess which taxa are primarily responsible for the observed differences among the four groups of samples/habitats, we applied a SIMPER (Similarity Percentage) analysis in PAST version 5.2 using the Bray–Curtis similarity measure (Clarke 1993, Hammer 2025). As an alternative to SIMPER for identifying specialist, generalist, or rare species of a given habitat (Dufrene and Legendre 1997), we performed an indicator species analysis (IndVal) in which the statistical significance (p-values) of the indicator values was estimated using 9,999 random permutations of species across habitats (Hammer 2025). All the statistics were considered significant for $p < 0.05$.

Results

Species richness and sampling effort.—A total of 48 grasshopper species were sampled in this study, belonging to three families: Acrididae MacLeay, 1821 (39 species), Pyrgomorphidae Brunner von Wattenwyl, 1874 (eight species), and Thericleidae Burr, 1899 (one species) (Appendix 1: Table A1). These species include 10 species of Acridinae (Fig. 3A–F), eight of Catantopinae Brunner von Wattenwyl, 1893 (Fig. 4A–D), eight of Pyrgomorphinae (Fig. 5A–G), six of Oedipodinae Walker, 1871 (Fig. 6E–H), five of Coptacrinae Brunner von Wattenwyl, 1893 (Fig. 5H), four of Cyrtacanthacridinae Kirby, 1910 (Fig. 6A–D), three of Eyprepocnemidinae Brunner von Wattenwyl, 1893 (Fig. 4E–G), two of Oxyinae Brunner von Wattenwyl, 1893 (Fig. 3G–H), one of Calliptaminae Jacobson, 1905 (Fig. 4H), and one of Thericleinae.

In general, the most species-rich habitat was fallowland (39 species), followed by crop field (33 species), bare soil (21 species), and forest (12 species). Among the vegetation types, sampling was most efficient in bare soil (95%), followed by

Fig. 3. Acridinae and Oxyinae from the Bangou district. **A.** *Acrida bicolor*, 16–IX–2024 in crop field; **B.** *Cannula gracilis*, 26–VII–2024 in fallowland; **C.** *Coryphosima stenoptera*, 24–VI–2024 in fallowland; **D.** *Gymnobothrus cruciatus*, 24–IX–2024 in crop field; **E.** *Odontomelus kamerunensis*, 24–II–2024 in forest; **F.** *Roduniella insipida*, 24–IX–2024 in bare soil; **G.** *Pterotiltus coeruleocephalus*, 24–VI–2024 in forest; **H.** *Parapterotiltus minimoides*, 29–VIII–2024 in forest.

fallowland (92%), forest (80%), and farmland (75%) (Appendix 1: Table A1). In these vegetation types, the individual rarefaction curve began to flatten toward 600 individuals in fallowland, 450 specimens in crop land, 100 individuals in forest, and 75 specimens in bare soil (Fig. 2). The overall species sampling effort was high, achieving 90% efficiency (Appendix 1: Table A1). We collected 48 of the 53 expected species (48/53): 33/44 (75%) species in crop field, 12/15 (80%) taxa in forest, 39/42 (92%) species in fallowland, and 21/22 (95%) taxa in bare soil (Appendix 1: Table A1). Two species (*Catantops melanostictus* Schaum,

Fig. 4. Catantopinae, Eyprepocnemidinae, and Calliptaminae from the Bangou district. **A.** *Catantops melanostictus*, 27–III–2024 in fallowland; **B.** *Hadrolecocatantops glauningi*, 26–II–2024 in crop field; **C.** *Criotocatantops pulchripes*, 12–IX–2024 in fallowland; **D.** *Exopropacris rehni*, 26–X–2024, photo in lab; **E.** *Eyprepocnemis noxia*, 16–I–2024 in forest; **F.** *Eyprepocnemis plorans*, 26–V–2024 in crop field; **G.** *Heteracris guineensis*, 05–XII–2024 in forest; **H.** *Acorypha* sp., 28–III–2024 in bare soil.

1853 and *Gymnobothrus cruciatus* (Schaum, 1853)) were collected in all the four studied vegetation types. *Abisares viridipennis* (Burmeister, 1838) and *Occidentosphena uvarovi* (Rehn, 1942) were found only in crop field. *Parapetasia rammei* Sjöstedt, 1923, *Parapterotiltus minimoides* Oumarou Ngoute & Rowell, 2024, *Parepistaurus* sp., and *Thericles* sp., were found only in the forest; *Cannula gracilis* (Burmeister, 1838), *Criotocatantops pulchripes* (Karny, 1917), *Eucoptacra exigua* Bolívar, 1912, *Eucoptacra gowdeyi* Uvarov,

Fig. 5. Pyrgomorphinae and Coptacrinae from the Bangou district. **A.** *Dictyophorus griseus*, 07–VI–2024 in bare soil; **B.** *Chrotogonus homalodemus*, 27–III–2024 in bare soil; **C.** *Occidentosphena uvarovi*, 21–IX–2024 in fallowland; **D.** *Parapetasia rammei*, 24–V–2024, in forest; **E.** *Pyrgomorpha vignaudii*, 24–IX–2024 in crop field; **F.** *Taphronota calliparea*, 27–III–2024 in forest; **G.** *Zonocerus variegatus*, 23–IX–2024 in fallowland; **H.** *Eucoptacra gowdeyi*, 25–V–2024 in fallowland.

1923, *Exopropacris rehni* (Sjöstedt, 1923), *Machaeridia bilineata* Stål, 1873, *Ornithacris cyanea* (Stoll, 1813), and *Acorypha* sp. were collected only in fallowland. No taxa were specific to bare soil habitat (Appendix 1: Table A1).

Abundance and abundance distribution model.—Among the 1191 grasshopper specimens sampled, 561 (47.10%) were collected from fallowland, 449 (37.70%) from crop field, 126 (10.58%) from bare soil, and 55 (4.62%) from forest (Appendix 1: Table A1).

Fig. 6. Cyrtacanthacridinae and Oedipodinae from the Bangou district. **A.** *Ornithacris cyanea*, 28–III–2024 photo in lab; **B.** *Cyrtacanthacris tatarica*, 24–II–2024 in fallowland; **C.** *Cyrtacanthacris aeruginosa*, 16–I–2024 in forest; **D.** *Gastrimargus africanus*, 23–IX–2024, in fallowland; **E.** *Heteropternis thoracica*, 24–IX–2024 in bare soil; **F.** *Morphacris fasciata*, 16–I–2024 in forest; **G.** *Trilophidia repleta*, 23–IX–2024 in fallowland; **H.** *Trilophidia conturbata*, 23–IX–2024 in crop field.

We observed statistical differences in the mean of relative abundances ($H = 32.50$, $p < 0.0001$) between the vegetation types; the values were higher in fallowland, followed by crop field, bare soil, and lower in forest (Fig. 7). The studied grasshopper species were categorized as either 'abundant' (one species), 'less abundant' (22 species), or 'rare' (25 species) (Appendix 1: Table A1). *Coryphosima stenoptera* (Schaum, 1853) was the only abundant species (29.7%). Among the less abundant taxa, *Orthochtha nigricornis*

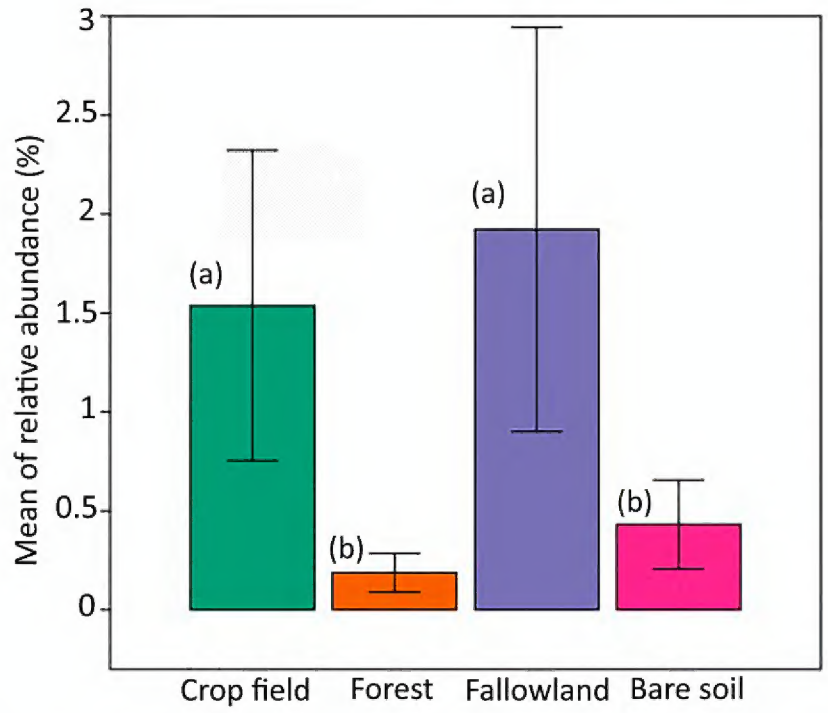

Fig. 7. Mean relative abundances of grasshoppers in the studied vegetation types. The x-axis shows the mean abundance in each habitat as bars, with error bars representing the 95% confidence interval. Results of pairwise comparisons are indicated by "(a)" or "(b)".

(Karsch, 1893) (7.64%) and *Roduniella insipida* (Karsch, 1896) (7.64%) had more individuals: about twice as many as *C. melanostictus* (4.70%), *Heteropternis thoracica* (Walker, 1870) (4.61%), *Chrotogonus homalodemus* (Blanchard, 1836) (4.03%), and *Heteropternis couloniana* (de Saussure, 1884) (3.27%) and four times more than *Trilophidia conturbata* (Walker, 1870) (2.68%), *Hadrolecocatantops glauningi* (Ramme, 1929) (2.60%), *Eyprepocnemis plorans* (von Charpentier, 1825) (2.09%), *G. cruciatus* (2.01%), *Epistaurus bolivari* Karny, 1907 (2.01%), *M. bilineata* (1.93%), *Eucoptacra anguliflava* (Karsch, 1893) (1.59%), and *Pyrgomorpha vignaudii* (Guérin-Méneville, 1847) (1.59%). The other remaining species represented less than 1.50% of the collected specimens. Acrididae (90.68%) were very abundant, Pyrgomorphidae (8.90%) less abundant, and Thericleidae (0.41%) were rare. Acridinae was very abundant (54.66%), while Oedipodinae (12.76%), Catantopinae (9.32%), and Pyrgomorphinae (8.90%) were less abundant. Oxyinae (1.18%) dominated in forest habitat, whereas Pyrgomorphinae (4.11%) were most abundant in bare soil (Appendix 1: Table A1). In general, grasshopper species were more abundant in the rainy season (64.73%) than in the dry season (35.26%) (Appendix 1: Table A1) with March, May, August, and October being the richest months (Fig. 8). However, it was during the dry season that pest grasshopper species such as *E. plorans* and *C. melanostictus* were most active in cultivated fields (Fig. 8). The studied species were distributed into 22 ranks of abundance in bare soil, 22 ranks in fallowland, 13 ranks in forest, and six octaves in crop field (Fig. 9). The distribution models of species abundance were close to (all the p-values < 0.001) Motomora's geometric model in bare soil (Fig. 9A) as in fallowland (Fig. 9D), to the MacArthur's broken stick model in forest (Fig. 9B), and Preston's log-normal model in crop field (Fig. 9C).

Frequency of occurrence.—Our study revealed a statistical difference ($H = 33.31$, $p < 0.0001$) in the grasshopper distributions of frequency of occurrence between the studied habitats; the medians were higher in fallowland, followed by crop field, bare soil, and lower in forest (Fig. 10). *Coryphosima stenoptera* (60.41%) was the only constant species in our samples. Eight other accessory species were collected. Among these, the most common species was *R. insipida* (43.75%), followed by *C. melanostictus* (41.66%), *H. thoracica* (33.33%), *T. conturbata* (33.33%), *E. plorans* (27.08%), *C. homalodemus* (27.08%), and *E. bolivari* (27.08%). All other taxa occurred only accidentally in our samples (Appendix 1: Table A1).

Diversity and similarity.—The Shannon index revealed higher grasshopper diversity in fallowland ($H' = 2.42$), followed by crop field ($H' = 2.23$), bare soil ($H' = 2.14$), and forest ($H' = 2.11$) (Fig. 2B). Furthermore, the PCA showed that the two grasshopper communities in crop field and fallowland were close to each other and the communities from forest and bare soil were similar. The vectors in the PCA showed strong correlations with the most disturbed landscapes (Fig. 11).

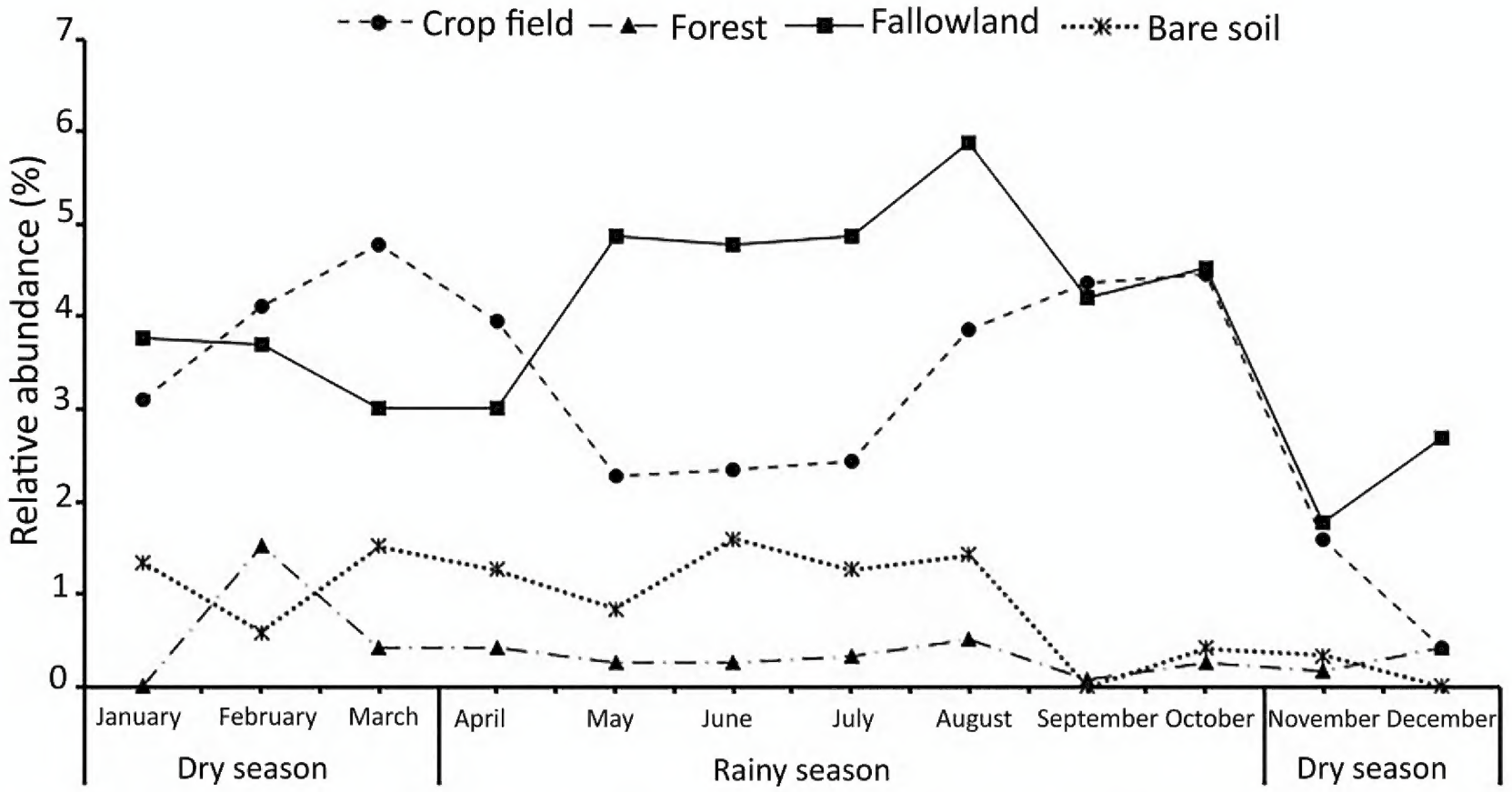

Fig. 8. Relative abundance of grasshoppers across the year in the studied vegetation types (habitats). The x-axis represents relative abundance, calculated as the sum across all sampling events for each month.

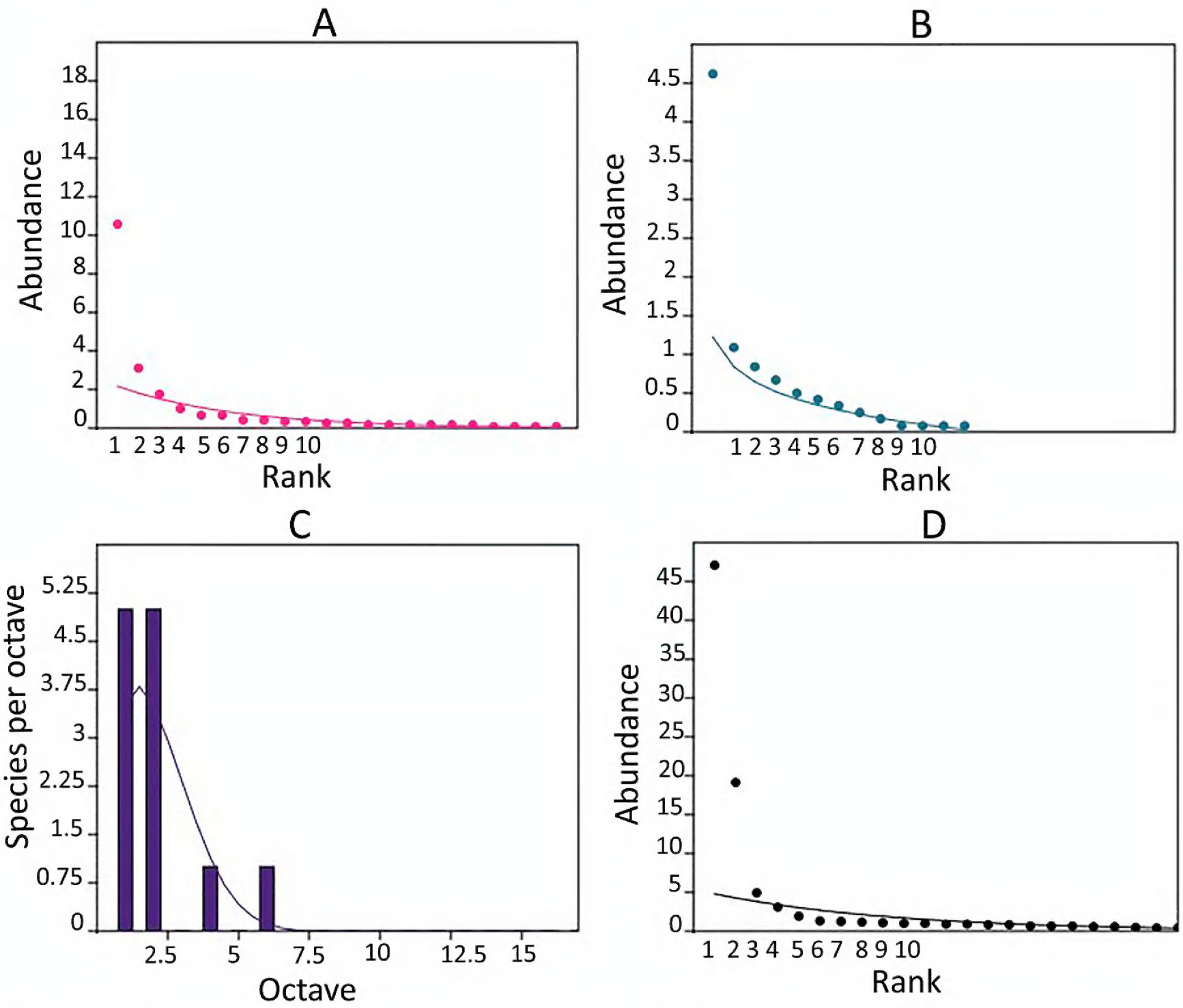

Fig. 9. Abundance distribution models of grasshopper assemblages across the studied vegetation types. **A.** Bare soil; **B.** Forest; **C.** Crop field; **D.** Fallowland. In **A, B, and D**, the x-axis shows species ranked in descending abundance on a logarithmic scale (Whittaker plot). In **C**, the y-axis represents the number of species within abundance octave classes (power-of-2 abundance classes).

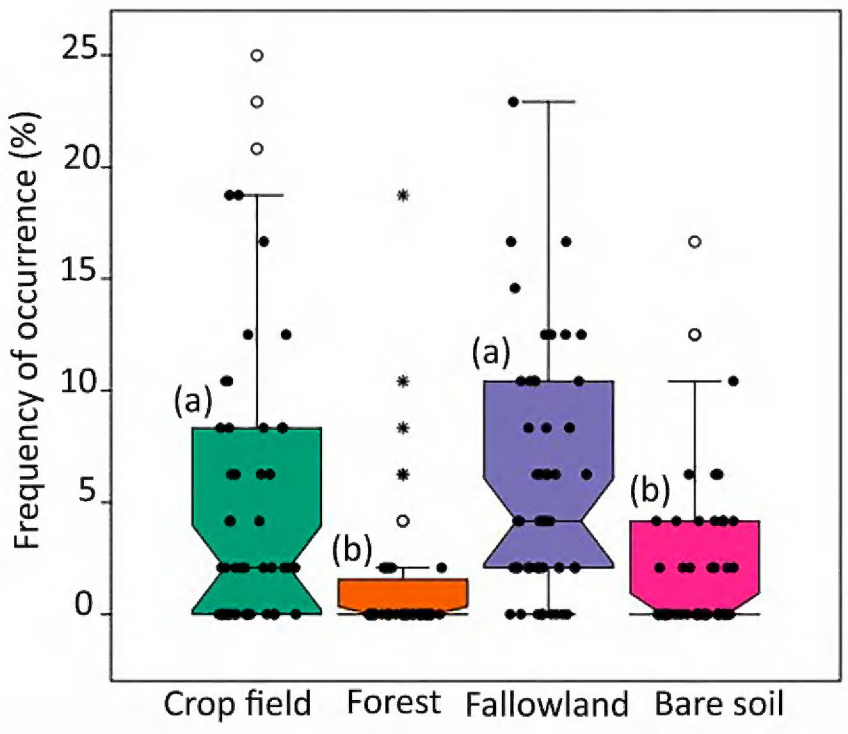

Fig. 10. Frequency distributions of grasshoppers across the studied vegetation types. The x-axis represents each habitat type. Boxes show the interquartile range, with the median indicated by a horizontal line. Points outside the inner fences are shown as circles, and points beyond three times the box height (outer fences) are marked with stars. Pairwise comparison results are indicated by "(a)" or "(b)".

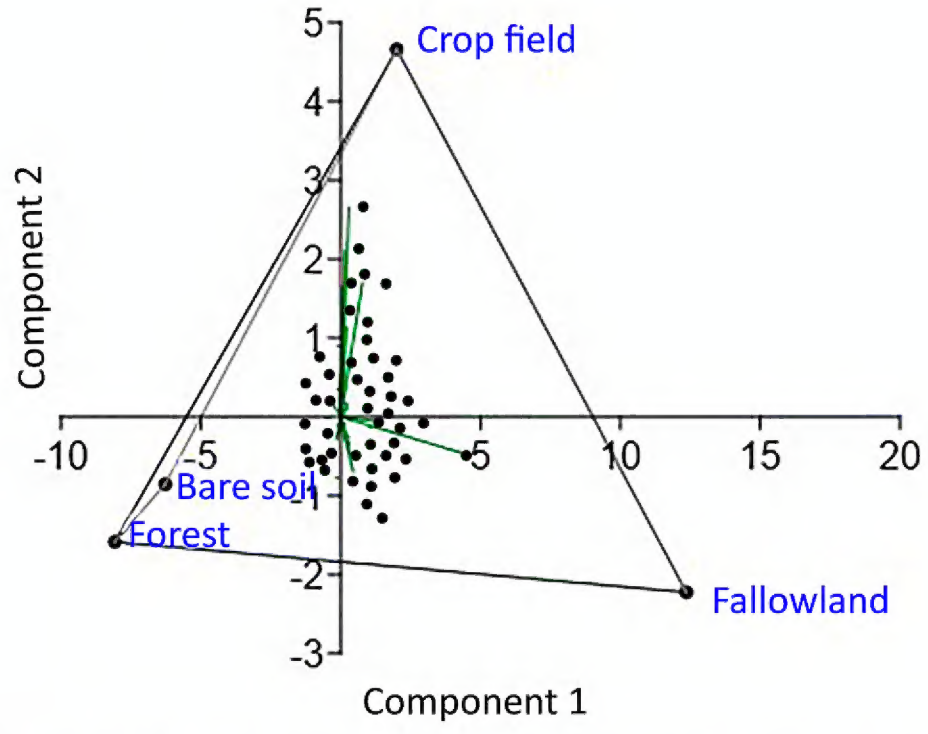

Fig. 11. Similarity among grasshopper assemblages across the studied habitats, assessed using Principal Component Analysis (PCA). The first two components represent the main axes capturing the most significant differences among habitats and species. **PC1** explains the largest portion of variation in the abundance data, while **PC2** explains the second-largest portion, uncorrelated with PC1.

Species status.—*Coryphosima stenoptera* (Av. dissim. = 21.07, Contrib. = 23.49%) was the species that contributed most to explaining the observed differences among the four studied habitats (Appendix 1: Table A2). *Chrotogonus homalodemus* (Av. dissim. = 5.89), *O. nigricornis* (Av. dissim. = 5.67), *R. insipida* (Av. dissim. = 5.50), *H. thoracica* (Av. dissim. = 4.08), *C. melanosticus* (Av. dissim. = 4.03), and *H. couloniana* (Av. dissim. = 2.99) each contributed less than 7% (Appendix 1: Table A2). Each of the other taxa had a Contrib. < 3.00%. Four species—*Thericles* sp. (IndVal = 33.33%, p = 0.002), *P. minimoides* (IndVal = 25%, p = 0.01), *Parepistaurus* sp. (IndVal = 75%, p < 0.001), and *Pterotiltus coeruleocephalus* (IndVal = 37.04%, p = 0.001)—were identified as bioindicators or specialists of forest habitat. One taxon, *C. homalodemus* (IndVal = 51.39%, p < 0.001), was identified as a specialist of bare soil (Table 1). Six species were categorized as non-specialists: *Acrida bicolor* (IndVal = 22.73, p = 0.02), *Atractomorpha accutipennis* (IndVal = 15.63, p = 0.04), and *Dictyophorus griseus* (IndVal = 23.33, p = 0.01) in Fallowland; *A. viridipennis* (IndVal = 16.67, p = 0.05), *Cyrtacanthacris aeruginosa* (IndVal = 18.75, p = 0.04), and *Morphacris fasciata* (IndVal = 16.67, p = 0.04) in crop field; and *Odontomelus kamerunensis* (IndVal = 20.83, p = 0.03) in forest. The 14 remaining taxa were categorized as either generalists or rare species in the four studied landscapes. In general, the number and proportion of generalist species increased with land use or vegetation degradation: the IndVal proportions and *p-values* revealed one species (8%) in forest, four (19%) in bare soil, five (15%) in crop field, and 11 (28%) taxa in fallowland (Table 1). Rare species decreased with land use, accounting for 50% (6/12) in forest, 61% (13/21) in bare soil, 30% (10/33) in crop field, and 23% (9/39) in fallow land (Table 1).

Discussion

Species richness.—Our study confirms our first hypothesis, demonstrating that Bangou has high and endemic grasshopper diversity compared with other similar habitats in Cameroon. We found 48 short-horned grasshoppers in the studied vegetation types. Yetchom-Fondjo et al. (2020) identified 38 grasshopper species in the coastal area of the Littoral region of Cameroon, while Oumarou Ngoute et al. (2023) collected 43 species in the south Cameroon plateau. Previously, Kekeunou et al. (2017) reported 27 species in the Kouoptamo district in West Cameroon, and Seino et al. (2013) documented 28 species in the Menoua division, West Region. Such observations might stem from the varying climatic characteristics, altitude variations, and vegetation types across the above-cited regions of Cameroon. Indeed, the south Cameroon plateau (about 650 m above sea level) is under a Guinean climate type with four seasons, two rainy seasons and two dry seasons, and annual rainfall between 1,500 mm to 2,000 mm (Njopkou, 2014); the Littoral region (in the coastal area) is under a Cameroonian climate type, humid and hot, with two seasons and unimodal distribution of rainfall (4,000 mm per year) (Letouzey 1985); while the West region (in the highland area) has a Cameroonian-type climate, dry and cool, with two seasons (Santoir and Bobda 1995). Furthermore, the high species richness in our work can be justified by the fact that Bangou is in the Cameroon Volcanic Line. This volcanic line is recognized worldwide as a hotspot of biodiversity in the Congo Basin, with a high rate of endemism (Rejou-Mechain et al. 2021, Zwets et al. 2024). The same observation has been made in other volcanic zones in Africa (Rowell and Hemp 2017, Rowell and Hemp 2018, Rowell et al. 2015). A decade earlier, Hemp (2009) reported a list of 139 Orthoptera Caelifera (Tetrigoidea, Eumastacoidea, and Acridoidea) in Mt Kilimanjaro in East Africa, and Roy (2003) collected 110 species of Acridomorpha (Eumastacoidea and Acridoidea) from the Nimba mountain and its surroundings in West Africa.

Our study shows that grasshopper species richness was higher in herbaceous vegetation (fallowland: 39 species, crop field: 33 species), whereas habitats with limited herbaceous cover (bare ground: 21 species, forest: 12 species) had the lowest species richness. Theron et al. (2022) in the KwaZulu-Natal Midlands in South Africa and Yetchom-Fondjo et al. (2020) in the Littoral region in Cameroon also showed a positive correlation between grasshopper species richness and the presence of a herbaceous layer in the environment. In the latter study, a total of 32 species were recorded in crop field, 29 in fallowland, and 7 additional species in forest (Yetchom-Fondjo et al. 2020).

Abundance, occurrence, and distribution model.—Our results also support our second hypothesis, showing that the grasshopper community varies markedly across the four habitat types, each of which supports a distinct species assemblage. Indeed, the present study revealed high grasshopper species abundance and occurrence in herbaceous vegetation (crop field: 37.70%, fallowland: 47.10%), whereas in forest (4.62%) and bare soil (10.58%), we observed low species diversity, indicating an increase in the Shannon (H´) index diversity with land-use intensification.

Plant and herbivorous insect communities are likely to differ among habitat types (Nakajima and Miyashita 2021). Grasshoppers are known to be diversified in grassland ecosystems in which they feed on gramineous plants (Masaki et al. 2011). However, in the Pampas region of Argentina (2.51% of individuals in crop, 51.87% in grassland), as well as in the Al-Tebbin region (South Cairo) of Egypt (402.6 ± 27 of specimens in highly polluted station, 594.6 ± 23.3 in moderately polluted station), grasshopper species diversity decreased after environmental perturbation (Soliman et al. 2017, Mariottini et al. 2024). The effect of land use on grasshopper biodiversity likely depends on eco-climatic areas and climates, which are a function of the relief and vegetation types. Land use fragments grasshopper communities into different assemblages leading to a proliferation or a decrease in species' population size depending on the available habitats (Nakajima and Miyashita 2021, Mariottini et al. 2024, Oumarou Ngoute 2025). Three distinct species abundance distribution models emerged in our study: the geometric model in bare soil and fallowland, the broken stick model in forest habitat, and the log-normal model in crop field. The observed models corresponded closely to the variations in vegetation structure and disturbance intensity across the studied habitats. The broken-stick distribution in forest confirmed the less disturbed habitat described in our study. The studied forests have high plant species diversity, including trees, shrubs, and herbaceous; this environment leads to minimal interactions between the studied grasshopper species because of the available resources (Fattorini et al. 2016, Zang et al. 2022). The limited and often monospecific plant diversity in the studied fallowland (herbaceous) and bare soil (no vegetation) corroborated the geometric model, which revealed a heavily disturbed ecosystem marked by strong interspecific competition (Fattorini et al. 2016). However, the log-normal model in crop field with moderate species interactions and abundances (Zang et al. 2022) is somewhat unusual. This result can be explained by the polyculture, or mixed cropping, observed and described in the Bangou district. Polyculture creates a diversity of plant resources that provides multiple ecological niches, allowing most species to maintain moderate abundances, while only a few remain very rare or highly dominant, producing a characteristic of the log-normal distribution. Fried et al.

Table 1. IndVal metrics of grasshoppers indicating specialist, non-specialist, generalist, and rare species. Values are presented as IndVal (%) (*p-value*). Specialist species (indicative species): IndVal (%) > 25 %, $p < 0.05$. Non-specialist species: 10 % ≤ IndVal (%) ≤ 25 %, $p > 0.05$. Generalist species: 5 % ≤ IndVal (%) < 10 %, $p > 0.05$. Rare species: IndVal (%) < 5 %, $p > 0.05$.

Taxa	Crop field	Forest	Fallowland	Bare soil
Acrida bicolor	9.09(0.24)	0(1)	22.73(0.02)	0.75(0.85)
Acrida sulphuripennis	5(0.41)	0(1)	6.66(0.25)	5(0.40)
Cannula gracilis	0(1)	0(1)	41.67(<0.001)	0(1)
Coryphosima stenoptera	29.66(0.05)	0(1)	59.04(<0.001)	2.96(0.98)
Gymnobothrus cruciatus	12.5(0.21)	0.34(0.98)	25(0.02)	1.38(0.91)
Machaeridia bilineata	0(1)	0(1)	58.33(<0.001)	0(1)
Odontomelus kamerunensis	0(1)	20.83(0.03)	1.38(0.58)	0(1)
Orthochtha nigricornis	10.26(0.31)	0(1)	43.22(<0.001)	0.73(0.93)
Parga cyanoptera	5.95(0.76)	0(1)	38.69(<0.001)	0(1)
Roduniella insipida	42.12(<0.001)	0(1)	27.11(0.03)	2.19(0.96)
Abisares viridipennis	16.67(0.05)	0(1)	0(1)	0(1)
Anthermus sp.	0(1)	0(1)	6.66(0.25)	1.66(0.44)
Catantops melanostictus	44.20(0.001)	1.19(0.98)	3.12(0.92)	10.71(0.45)
Criotocatantops pulchripes	0(1)	0(1)	8.33(0.25)	0(1)
Crobylostenus sp.	2.08(0.58)	0(1)	12.5(0.10)	0(1)
Exopropacris rehni	0(1)	0(1)	8.33(0.25)	0(1)
Hadrolecocatantops glauningi	29.57(0.007)	0.26(0.94)	6.45(0.35)	0(1)
Phaeocatantops signatus	18.18(0.03)	2.27(0.42)	0(1)	0(1)
Epistaurus bolivari	27.08(0.01)	0(1)	8.33(0.41)	5.20(0.62)
Eucoptacra anguliflava	0.87(0.89)	0(1)	39.47(0.001)	0.87(0.88)
Eucoptacra exigua	0(1)	0(1)	41.67(<0.001)	0(1)
Eucoptacra gowdeyi	0(1)	0(1)	8.33(0.25)	0(1)
Parepistaurus sp.	0(1)	75(<0.001)	0(1)	0(1)
Acanthacris ruficornis	26.67(0.006)	0(1)	3.33(0.47)	0(1)
Cyrtacanthacris aeruginosa	18.75(0.04)	0(1)	2.08(0.70)	0(1)
Cyrtacanthacris tatarica	2.77(0.44)	0(1)	5.55(0.25)	0(1)
Ornithacris cyanea	0(1)	0(1)	8.33(0.24)	0(1)
Acorypha sp.	0(1)	0(1)	50(<0.001)	0(1)
Eyprepocnemis noxia	0.55(0.81)	0(1)	38.89(0.001)	0(1)
Eyprepocnemis plorans	63(<0.001)	0(1)	1.33(0.92)	1.33(0.92)
Heteracris guineensis	2.77(0.58)	2.77(0.57)	2.77(0.59)	0(1)
Gastrimargus africanus	2.77(0.58)	0(1)	11.11(0.15)	0(1)
Heteropternis couloniana	44.87(<0.001)	0(1)	1.28(0.79)	0.21(0.91)
Heteropternis thoracica	76.67(<0.001)	0(1)	4.84(0.72)	0.15(0.99)
Morphacris fasciata	16.67(0.04)	0(1)	0.83(0.78)	6.66(0.28)
Trilophidia conturbata	27.08(0.02)	0(1)	8.59(0.44)	10.42(0.37)
Trilophidia repleta	0.64(0.91)	0(1)	42.31(<0.001)	0.64(0.92)
Parapterotiltus minimoides	0(1)	25(0.01)	0(1)	0(1)
Pterotiltus coeruleocephalus	0.92(0.82)	37.04(0.001)	0(1)	0(1)
Thericles sp.	0(1)	33.33(0.002)	0(1)	0(1)
Atractomorpha accutipennis	1.04(0.77)	0(1)	15.63(0.04)	2.08(0.54)
Chrotogonus homalodemus	6.94(0.46)	0(1)	0.17(0.98)	51.39(<0.001)
Dictyophorus griseus	0(1)	0(1)	23.33(0.01)	5(0.44)
Occidentosphena uvarovi	8.33(0.24)	0(1)	0(1)	0(1)
Parapetasia rammei	0(1)	8.33(0.25)	0(1)	0(1)
Pyrgomorpha vignaudii	26.32(0.01)	0(1)	6.57(0.42)	1.74(0.81)
Taphronota calliparea	17.86(0.06)	4.76(0.37)	0(1)	0(1)
Zonocerus variegatus	2.77(0.65)	0(1)	10.42(0.20)	10.42(0.20)

(2010) showed that monocultures contain significantly more specialist species than crop rotations, indicating that rotations mainly promote generalist species rather than specialists tied to each crop type. In general, human-driven forest clearing provides favorable conditions for grasshopper species associated with herbaceous or grassland vegetation but threatens other vulnerable taxa (Oumarou Ngoute et al. 2023). Indeed, in the Bangou district, environmental degradation has promoted an increase in the density of pest taxa such as *E. plorans* or *C. melanostictus*, along with their activities in croplands, whereas other taxa, such as *P. minimoides* or *P. rammei*, have been threatened by human disturbance and are now restricted to the remaining small forest patches.

Similarity and species status.—Our results also confirm the third hypothesis, showing that the proportion of habitat generalist species varies across ecological zones, with a higher occurrence of generalists in more disturbed areas.

The PCA revealed correlations between the most disturbed habitats, showing that the proportion of generalist species increased with habitat disturbance (forest 8%, crop field 15%, bare soil 19%, fallowland 28%), while rare taxa declined. In investigating the invasion impacts of the grass species *Eragrostis curvula* on 12 native grasshopper species on the gravelly floodplains of the Kinu River, Yoshioka et al. (2010) supported the hypothesis that grasshopper species with specific habitat preferences are more affected by the invasion of weeping lovegrass than habitat generalists. In the Cape Floristic Region of South Africa, highly mobile, generalist-feeding grasshopper species occupy a greater number of habitat patches across the landscape, whereas low-mobility specialist feeders and rare taxa are restricted to high-quality natural patches that remain continuously available (Adu-Acheampong and Samways 2019). When studying the feeding behavior of the generalist grasshopper *Chorthippus parallelus*, Franzke et al. (2010) concluded that generalist herbivores can compensate for the potential nutritional deficiencies of single food plants through selective dietary mixing. Empirically, studies have shown that, unlike species with specialized resource requirements, generalist species may actually benefit from habitat destruction (Ramiadantsoa et al. 2018). However, according to Unsicker et al. (2010), decreasing biodiversity threatens the persistence of both specialist and generalist insect herbivores through multiple mechanisms, including the reduced diversity of food plants available to generalists.

Ecological niches remain a key framework for explaining variations in community structure. The balance depends on the types of resources exploited, the biotopes, and the niche space occupied. These factors vary across regions and generate taxonomic biases favoring either generalists or specialists (Dennis et al. 2011). In the context of our study, most specialist species were particularly vulnerable to extinction. In the complex, dynamic metapopulation landscape of local adaptation and migration, generalist strategies can enhance persistence (Dennis et al. 2011, Ramiadantsoa et al. 2018). By differing in their resource use, they are also more likely to coexist, even under highly variable environmental conditions.

Conclusion

The study demonstrates that grasshopper communities in the Bangou district are closely associated with habitat structure. Compared with other regions, our results highlight the influence of vegetation cover, climate, and land use on grasshopper biodiversity. Herbaceous habitats such as fallowland and crop field supported the highest species richness and abundance, while forest and bare soil ecosystems hosted fewer but more specialized taxa. Indeed, *Chrotogonus homalodemus* was identified as a specialist in bare soil, and *Parapterotiltus minimoides, Pterotiltus coeruleocephalus, Parepistaurus* sp., and *Thericles* sp. were classified as bioindicators of forest habitat. The generalist species increased in both number and relative proportion along the gradient of land use or vegetation degradation, whereas the proportion of rare species was lower in the most disturbed lands. Polyculture increases plant-resource diversity and thus multiplies ecological niches, enabling most species to persist at moderate abundances while only a few taxa become very rare or highly dominant, ultimately favoring generalist species. The abundance distribution of *Coryphosima stenoptera* effectively accounted for the observed dissimilarities among the studied lands. Overall, the landscape of the Bangou district, located on the Cameroon Volcanic Line, represents an important hotspot of grasshopper diversity, harboring both endemic taxa and numerous habitat specialist species. This emphasizes the need for sustainable land management practices that maintain herbaceous cover while conserving the remaining forest patches. Protecting habitat heterogeneity is essential to preserve the observed grasshopper diversity, ecological functions, and the long-term stability of natural ecosystems.

Acknowledgements

We thank all the members of the Zoology Unit of the Laboratory of Animal Biology and Physiology at the University of Douala who helped in the lab. We extend our gratitude to the administrative authorities and villagers of the Bangou district for facilitating our work in West Cameroon. This study was financially supported by the special research funding from the Ministry of Higher Education (MINESUP) in Cameroon.

References

Adu-Acheampong S (2017) Response of grasshoppers to the agricultural mosaics of the Cape Floristic Region biodiversity hotspot in South Africa. Doctorate of Philosophy, Faculty ofAgriSciences, Stellenbosch University, Stellenbosch, RSA.

Adu-Acheampong S, Samways MJ (2019) Traits and land transformation change the fortunes of grasshopper generalists vs. specialists in a biodiversity hotspot. Biosystems Diversity 27: 26–32. https://doi.org/10.15421/011904

Blanchard CÉ (1836) Monographie du genre *Ommexecha* de la famille des Acridiens. Annales de la Société Entomologique de France 5: 603–624.

Bolívar I (1912) Orthoptères nouveaux recueillis par le Dr. Sheffield Neave dans le katanga. Mémoires de la Société entomologique de Belgique 19: 73–99.

Brénac P (1988) Evolution de la végétation et du climat dans l'Ouest-Cameroun entre 25000 et 11000 ans BP. In: Symposium APLF. Travaux de la Section Scientifique et Technique de l'Institut Français de Pondichéry, 225, p. 91–103. Symposium de l'Association des Palynologues de Langue Française, 10., Bordeaux, France.

Brunner von Wattenwyl C (1874) Ueber Systematik der Orthoptera und die Recensio orthopterorum von C. Stal. Verhandlungen der Kaiserlich-Königlichen Zoologisch-Botanischen Gesellschaft in Wien 24: 225–230.

Brunner von Wattenwyl C (1893) Révision du système des Orthoptères et déscription des espèces rapportées par M. Leonardo Fea de Birmanie. Annali del Museo Civico di Storia Naturale di Genova 13: 1–230. https://doi.org/10.5962/bhl.title.5121

Burmeister HCC (1838) Kaukerfe, Gymnognatha (Erste Hälfte: Vulgo Orthoptera). In Handbuch der Entomologie. Theodor Christian Friedrich Enslin, Berlin 2: 397–756.

Burr M (1899) Essai sur les Eumastacides tribu des Acridiodea. Anales de la Sociedad Española de Historia Natural 28: 75–112.

Carlo HR, Help P, Herman MJ, Soetaert K (1998) Indices of diversity and evenness. Oceanis 24: 61–87.

Chandrakar AK, Dhuria SS (2019) Biodiversity: why it matters. Chhattisgarh Journal of Science and Technology 1: 20–23.

Chowdhury S, Dubey VK, Choudhury S, Das A, Jeengar D, Sujatha B, Kumar A, Kumar N, Semwal A, Kumar V (2023) Insects as bioindicator: A hidden gem for environmental monitoring. Frontiers in Environmental Science 11: 1146052. https://doi.org/10.3389/fenvs.2023.1146052

Cigliano MM, Braun H, Eades DC, Otte D (2025) Orthoptera species file. Version TaxonWorks. https://orthoptera.speciesfile.org [accessed October 09, 2025]

Clarke KR (1993) Non-parametric multivariate analysis of changes in community structure. Australian Journal of Ecology 18: 117–143. https://doi.org/10.1111/j.1442-9993.1993.tb00438.x

Dajoz R (1982) Précis d'écologie. Bordas, Paris.

da Silva ACS, dos Santos AS, dos Santos-Santana T, Winkaler EU, Lhano MG (2021) Activity of biochemical biomarkers in grasshoppers *Abracris flavolineata* (De Geer, 1773) (Orthoptera: Acrididae: Ommatolampidinae). Research, Society and Development 10: e409101119877. https://doi.org/10.33448/rsd-v10i11.19877

Dehling MD, Bender IMA, Blendinger PG, Böhning-Gaese K, Muñoz MC, Neuschulz EL, Quitián M, Saavedra F, Santillán V, Schleuning M, Stouffer DB (2021) Specialists and generalists fulfil important and complementary functional roles in ecological processes. Functional Ecology 35: 1810–1821. https://doi.org/10.1111/1365-2435.13815

Dennis RLH, Dapporto L, Fattorini S, Cook LM (2011) The generalism–specialism debate: the role of generalists in the life and death of species. Biological Journal of the Linnean Society 104: 725–737. https://doi.org/10.1111/j.1095-8312.2011.01789.x

de Saussure H (1884) Prodromus Oedipodiorum, Insectorum ex Ordine Orthopterorum. Mémoires de la Société de Physique et d'Histoire Naturelle de Genève 28 : 1–254. https://doi.org/10.5962/bhl.title.9514

Dirsh VM (1958) Revision of the genus *Eyprepocnemis* Fieber, 1853 (Orthoptera: Acrididae). Proceedings of the Royal Entomological Society 27: 33–45. https://doi.org/10.1111/j.1365-3113.1958.tb00407.x

Dirsh VM (1965) The African genera of Acridoidea. Anti-locust Research Centre, Cambridge University Press, Cambridge London.

Dirsh VM (1970) Acridoidea of the Congo (Orthoptera). AMR AC Musée royal d'Afrique central 182: 1–605.

Dufrene M, Legendre P (1997) Species assemblages and indicator species: The need for a flexible asymmetrical approach. Ecological Monographs 67: 345–366. https://doi.org/10.2307/2963459

Fartmann T, Poniatowski D, Holtmann L (2022) Effects of land-use and climate change on grasshopper assemblages differ between protected and unprotected grasslands. Basic and Applied Ecology 63: 83–92. https://doi.org/10.1016/j.baae.2022.06.005

Fattorini S, Rigal F, Cardoso P, Borges PAV (2016) Using species abundance distribution models and diversity indices for biogeographical analyses. Acta Oecologica 70: 21–28. https://doi.org/10.1016/j.actao.2015.11.003

Franzke A, Unsicker SB, Specht J, Kohler G, Weisser WW (2010) Being a generalist herbivore in a diverse world: How do diets from different grasslands influence food plant selection and fitness of the grasshopper *Chorthippus parallelus*? Ecological Entomology 35: 126–138. https://doi.org/10.1111/j.1365-2311.2009.01168.x

Fried G, Petit S, Reboud X (2010) A specialist-generalist classification of the arable flora and its response to changes in agricultural practices. BMC Ecology 10: 20. https://doi.org/10.1186/1472-6785-10-20

Grunshaw JP (1991) A revision of the grasshoppers' genus *Heteracris* (Orthoptera: Acrididae: Eyprepocnemidinae). Bulletin - Natural Resources Institute, University of Greenwich, United Kingdom.

Guérin-Méneville FE (1847) Insectes. In Voyage en Abyssinie dans les provinces du Tigré, du Samen et de l'Amhara: Volume 4(6). Paulin, Paris, France.

Haldar P, Malakar C (2017) Farming of grasshoppers for feed and food. In Van Huis A, Tomberlin J. Insects as food and feed: From production to consumption. Brill Wageningen Academic Publishers, Wageningen, Netherlands, 126–140. https://doi.org/10.3920/9789086868490_010

Hammer Ø (2024) PAST: Paleontological Statistics, Version 4.17. Natural History Museum, University of Oslo, Olslo, USA.

Hammer Ø (2025) PAST PAleontological STatistics Version 5.2. Natural History Museum, University of Oslo, Oslo, USA.

Hao S, Wang S (2015) Landscape level patterns of grasshoppers' communities in inner Mongolia: interactive effects of livestock and precipitation gradient. Landscape Ecology 30: 1–12. https://doi.org/10.1007/s10980-015-0247-8

Havyarimana F, Bigendako MJ, Masharabun T, Bangirinama F, Lejoly J, Barima YSS, De Cannière C, Bogaert J (2013) Diversité et distribution d'abondances des plantes d'un écosystème protégé dans un paysage anthropisé : cas de la réserve naturelle forestière de Bururi, Burundi. Tropicultura 31: 28–35.

Hemp C (2009) Annotated list of Caelifera (Orthoptera) of Mt. Kilimanjaro, Tanzania. Journal of Orthoptera Research 18: 183–214. https://doi.org/10.1665/034.018.0207

Hollis D (1975) A review of the subfamily Oxyinae (Orthoptera: Acridoidea). Bulletin of the British Museum (Natural History) Entomology 31: 189–234. https://doi.org/10.5962/bhl.part.29486

Jacobsen K, Fogain R, Mouassom H, De Waele D (2004) Musa-based cropping systems of the Cameroon highlands: a case study of the West and Northwest provinces of Cameroon, with emphasis on nematodes. Fruits 59: 311–318. https://doi.org/10.1051/fruits:2004029

Jacobson GG (1905) Orthoptera. In Orthopteroid and Pseudoneuropteroid Insects of Russian Empire and adjacent countries. Devrien Publisher, St. Petersburg, Russia.

Jago ND (1984) The alate genera of East African Catantopinae (Orthoptera: Acridoidea) including revision of the genus *Catantops* Shaum. Transactions of the American Entomological Society 110: 295–387.

Jago ND (1994a) *Odontomelus* I. Bolivar 1890 (Orthoptera: Acridoidea: Acrididae: Acridinae): savanna-woodland grasshoppers with a major radiation of flightless species in Eastern Africa. Tropical Zoology 7: 367–450. https://doi.org/10.1080/03946975.1994.10539266

Jago ND (1994b) Review of the African genera *Catantops* Schaum 1853, *Hadrolecocatantops* Jago 1984, and *Vitticatantops* Sjöstedt 1931 (Orthoptera, Acrididae, Catantopinae). Journal of Orthoptera Research 3: 69–85. https://doi.org/10.2307/3503411

Karny HH (1907) Ergebnisse der mit Subvention aus der Erbschaft Treitl unternommen zoologischen Forschungsreise Dr. Franz Werner's nach dem ägyptischen Sudan und Nord-Uganda. IX. Die Orthopteren fauna des ägyptischen Sudans und von Nord-Uganda (Saltatoria, Gressoria, Dermaptera) mit besonderer Berücksichtigung der Acridoideengattung *Catantops*. Sitzungsberichte der Österreichischen Akademie der Wissenschaften. Mathematisch-Naturwissenschaftliche Klasse 116: 267–378.

Karny HH (1917) Ergebnisse der Forschungsreise des Herrn Dr. Adalbert Klaptocz nach Französisch Guinea. Orthoptera und Oothecaria. Zoologische Jahrbücher. Abteilung für Systematik, Geographie und Biologie der Tiere 40: 119–146.

Karsch FAF (1891) Verzeichnis der von Herrn Dr. Paul Preuss in Kamerun erbeuteten Acridoideen. Berliner Entomologische Zeitschrift 36: 175–196. https://doi.org/10.1002/mmnd.18910360116

Karsch FAF (1893) Die Insecten der Berglandschaft Adeli im Hinterlande von Togo (Westafrika). Berliner entomologische Zeitschrift 38: 1–266. https://doi.org/10.5962/bhl.title.8524

Karsch FAF (1896) Neue Orthopteren aus dem tropischen Afrika. Stettiner Entomologische Zeitung 57: 242–359. https://doi.org/10.5281/zenodo.16028887

Keith D, Kevan ME (1969) A revised synopsis of the genus *Atractomorpha* Saussure, 1862 (Orthoptera: Pyrgomorphidae) with an account of the African aberrans-groups. Zoological Journal of the Linnean Society 48: 141–198. https://doi.org/10.1111/j.1096-3642.1969.tb00710.x

Keith D, Kevan ME (1974) A revision of the genus *Taphronota* Stal, 1873 (Orthoptera: Acrididae: Pyrgomorphidae). Zoological Journal of the Linnean Society 88: 79–149.

Kekeunou S, Membou DT, Tamesse JL, Oumarou-Ngoute C (2017) Acrididea diversity in degraded areas of higher mountains in West Cameroon. African Entomology 25: 239–243. https://doi.org/10.4001/003.025.0239

Kirby WF (1910) A Synonymic Catalogue of Orthoptera (Orthoptera Saltatoria, Locustidae vel Acrididae). British Museum (Natural History), London, United Kingdom.

Larsen BB, Miller EC, Rhodes MK, Wiens JJ (2017) Inordinate fondness multiplied and redistributed: the number of species on Earth and the new Pie of Life. The Quarterly Review of Biology 92: 229–265. https://doi.org/10.1086/693564

Latchininsky AV (2008) Grasshopper outbreak challenges conservation status of a small Hawaiian Island. Journal of Insect Conservation 12: 343–357. https://doi.org/10.1007/s10841-008-9143-8

Latchininsky AV, Sword GA, Sergeev MG, Cigliano MM, Lecoq M (2011) Locusts and grasshoppers: Behavior, ecology and biogeography. Psyche, e578327. https://doi.org/10.1155/2011/578327

Leksono AS, Yanuwiadi B, Afandhi A, Farhan M, Zairina A (2020) The abundance and diversity of grasshopper communities in relation to elevation and land use in Malang, Indonesia Biodiversitas 21: 5614–5620. https://doi.org/10.13057/biodiv/d211206

Letouzey R (1985) Phytogeographic map of Cameroon on 1/500000 n°4, IRA-ICIV, University of Toulouse, France.

Li X, Wiens JJ (2023) Estimating global biodiversity: the role of cryptic insect species, Systematic Biology 72: 391–403. https://doi.org/10.1093/sysbio/syac069

MacLeay WS (1821) In Horae Entomologicae or Essays on the Annulose Animals. S. Bagster, 15, Paternoster-Row, London, United Kingdom. https://doi.org/10.5962/bhl.title.48636

Magara HJO, Hugel S, Fisher BL (2025) Nutritional composition of four edible grasshopper species frequently consumed in Madagascar: insights for nutritional contribution and alternative Insect Farming Foods 14: 1848. https://doi.org/10.3390/foods14111848

Manna B, Maiti S, Amlan Das A (2020) Bioindicator potential of *Spathosternum prasiniferum prasiniferum* (Orthoptera: Acridoidea) in pesticide (azadirachtin)-induced radical toxicity in gonadal/nymphal tissues; correlation with eco-sustainability Journal of Asia-Pacific Entomology 23: 350–357. https://doi.org/10.1016/j.aspen.2020.02.007

Marcon E (2018) Mesures De La Biodiversité. Kourou: UMR Ecologie des forêts de Guyane, Guyane, France. https://agroparistech.hal.science/cel-01205813v5

Mariño-Pérez R, Song H (2023) Pyrgomorphidae genera of the world: key to genera. Miscellaneous Publications Museum of Zoology, University of Michigan, USA.

Mariottini Y, De Wysiecki ML, Cepeda R, Marinelli C, Bardi CJ, Lange CE (2024) Grasshopper (Orthoptera: Acridoidea) diversity in the Pampas region of Argentina: status as revealed by long-term sampling. Journal of Insect Conservation 28: 1265–1283. https://doi.org/10.1007/s10841-024-00622-y

Masaki S, Murai T, Ito F (2011) Life history of grasshopper, cricket and katydid illustrated book, fourth and sixth editions. Hokkaido University Press, Hokkaido, Japan.

Midgley GF, Hannah L, Millar D, Thuiller W, Booth A (2003) Developing regional and species-level assessments of climate change impacts on biodiversity in the Cape Floristic Region. Biological Conservation 112: 87–97. https://doi.org/10.1016/s0006-3207(02)00414-7

Muller JF (1974) Aptitudes culturales des sols de l'Ouest - Cameroun : notion - établissement et utilisation des cartes. Office de la Recherche Scientifique et Technique Outre-Mer, Paris, France.

Nakajima K, Miyashita M (2021) Close association between grasshopper and plant communities in suburban secondary grasslands and the indicator value of grasshoppers for conservation. Landscape and Ecological Engineering. https://doi.org/10.1007/s11355-021-00447-w

Njopkou N (2014) Atlas nationale de développement physique du Cameroun. Institut National de Cartographie, Ministère de l'Economie de la Planification et de l'Aménagement du Territoire, Yaoundé, Cameroon.

Nkongho RN, Ibeku NE, Ndam LM, Agbor DT, Yinda GS (2024) A comparative analysis of the performance of common cropping systems used in the production of maize and selected grain legumes in Cameroon. Scientific African 24: e02131. https://doi.org/10.1016/j.sciaf.2024.e02131

Oumarou Ngoute C (2024) New records of *Gemeneta opilionoides* (Orthoptera: Catantopinae) in the world's second largest rainforest. Zootaxa 5519: 269–278. https://doi.org/10.11646/zootaxa.5519.2.6

Oumarou Ngoute C (2025) Acridofaune et Anthropisation, cas des forêts humides d'Afrique Centrale. Éditions Universitaires Européennes. East Finchley, London, United Kingdom.

Oumarou Ngoute C, Hunter D, Lecoq M (2021) Perception and knowledge of grasshoppers among indigenous communities in tropical forest areas of southern Cameroon: Ecosystem conservation, food security, and health. Journal of Orthoptera Research 30: 117–130. https://doi.org/10.3897/jor.30.64266

Oumarou Ngoute C, Kekeunou S, Bilong-Bilong CF (2023) Grasshopper (Orthoptera: Acridomorpha) diversity in response to fallow-land use in southern Cameroon with recommendations for land management. Journal of Insect Science 23: 1–12. https://doi.org/10.1093/jisesa/iead011

Oumarou Ngoute C, Kekeunou S, Lecoq M, Nzoko Fiemapong AR, Um Nyobe PCA, Bilong Bilong CF (2020) Effect of anthropogenic pressure on grasshopper (Orthoptera: Acridomorpha) species diversity in three forests in southern Cameroon. Journal of Orthoptera Research 29: 25–34. https://doi.org/10.3897/jor.29.33373

Oumarou Ngoute C, Rowell CHF (2024) New species of *Pterotiltus* from Cameroon, and a new genus, *Parapterotiltus* (Orthoptera: Acrididae: Oxyinae). Journal of Orthoptera Research 33: 127–146. https://doi.org/10.3897/jor.33.96043

Paul A, Frederich M, Uyttenbroeck R, Hatt S, Malik P, Lebecque S, Hamaidia M, Miazek K, Goffin D, Willems L, Deleu M, Fauconnier ML, Richel A, De Pauw E, Blecker C, Monty A, Francis F, Haubruge E, Danthine S (2016) Grasshoppers as a food source? A review. Biotechnology, Agronomy, Society and Environment 20: 337–352. https://doi.org/10.25518/1780-4507.12974

Poniatowski D, Beckmann C, Loffler F, Munsch T, Helbing F, Samways MJ, Fartmann T (2020) Relative impacts of land-use and climate change on grasshopper range shifts have changed over time. Global Ecology and Biogeography 29: 2190–2202. https://doi.org/10.1111/geb.13188

Ramiadantsoa T, Hanski I, Ovaskainen O (2018) Responses of generalist and specialist species to fragmented landscapes. Theoretical Population Biology 124: 31–40. https://doi.org/10.1016/j.tpb.2018.08.001

Ramme W (1929) Afrikanische Acrididae. Revisionen und Beschreibungen wenig bekannter und neuer Gattungen und Arten. Mitteilungen aus dem Zoologischen Museum in Berlin 15: 247–492.

Rehn JAG (1942) Notes on the species of the locust genus *Parasphena*, with descriptions of three new species. (Orthoptera, Acrididae, Pyrgomorphinae). Proceedings of the Academy of Natural Sciences of Philadelphia 94: 287–306.

Rejou-Mechain M, Mortier · F, Bastin JF, Cornu G, Barbier N, Bayol N, Benedet F, Bry X, Dauby G, Deblauwe V, Doucet JL, Doumenge C, Fayolle A, Garcia C, Kibambe-Lubamba JP, Toumeto JJ, Ngomanda A, Plotonl P, Sonke B, Trottier C, Vlmal R, Yongo O, Pelissier R, Gourlet-Fleury S (2021) Unveiling African rainforest composition and vulnerability to global change. Nature 593: 90–94. https://doi.org/10.1038/s41586-021-03483-6

Richmond CE, Breitburg DL, Rose KA (2005) The role of environmental generalist species in ecosystem function. Ecological Modelling 188: 279–295. https://doi.org/10.1016/j.ecolmodel.2005.03.002

Rowell CHF, Hemp C, Harvey AW (2015) Jago's Grasshoppers and Locusts of East and North East Africa, Vol. 1: Pneumoridae, Pyrgomorphidae, Lentulidae, Pamphagidae and Dericorythidae. Blurb Publishers, San Francisco, USA.

Rowell CHF, Hemp C (2017) Jago's Grasshoppers of East and North East Africa, Vol. 2. Acrididae: Teratodinae, Hemiacridinae, Spathosterninae, Tropidopolinae, Calliptaminae, Oxyinae, Coptacrinae and Eyprepocnemidinae. Blurb Publishers, San Francisco, USA.

Rowell CHF, Hemp C (2018) Jago's Grasshoppers of East and North East Africa, vol. 3. Acrididae: Catantopinae. Blurb Publishers, San Francisco, USA.

Rowell CHF, Oumarou-Ngoute C (2025) Review of *Pterotiltus* Karsch, 1893 (Orthoptera: Acrididae: Oxyinae). European Journal of Taxonomy 986: 1–104. https://doi.org/10.5852/ejt.2025.986.2853

Roy R (2003) Les Acridiens du Nimba et de sa région, in Lamotte M. & Roy R. (eds), Le peuplement animal du mont Nimba (Guinée, Côte d'Ivoire, Liberia). Mémoires du Muséum national d'Histoire naturelle, Paris, France.

Santoir C, Bopda A (1995) Atlas régional Sud-Cameroun. Orstom/Minrest, Paris-Yaoundé, France-Cameroon.

Schaum HR (1853) Ueber die von Peters mitgebrachten Orthoptera aus Mossambique. Uebersicht der von ihm in Mossambique beobachteten Orthopteren nebst Beschreibung der neu entdeckten Gattungen und Arten durch Herrn Dr. Hermann Schaum. Bericht über die zur Bekanntmachung geeigneten Verhandlungen der königlich Preussischen Akademie Wissenschaften zu Berlin 2: 775–780.

Seino RA, Dongmo TI, Ghogomu RT, Kekeunou S, Chifon RN, Manjelic Y (2013) An inventory of short-horned grasshoppers in the Menoua division, West Region of Cameroon. Agriculture and Biology Journal of North America 4: 291–299. https://doi.org/10.5251/abjna.2013.4.3.291.299

Sergeev MG (2021) Distribution patterns of grasshoppers and their kin over the Eurasian steppes. Insects 12: 77. https://doi.org/10.3390/insects12010077

Sjöstedt Y (1923) West-und Südafrikanische Acridiodeen. Arkiv för Zoologi 15: 1–21.

Soliman MM, Haggag AA, El-Shazly MM (2017) Assessment of grasshopper diversity along a pollution gradient in the Al-Tebbin region, South Cairo, Egypt. Journal of Entomology and Zoology Studies 5: 298–306.

Stål C (1873) Acridiodea. In Recensio Orthopterorum. Revue critique des Orthoptères décrits par Linné, De Geer et Thunberg, Stockholm, Sweden.

Stoll C (1813) In Représentation exactement colorée d'après nature des spectres ou phasmes, des mantes, des sauterelles, des grillons, des criquets et des blattes. J. Sepp, Amsterdam, Netherlands.

Theron KJ, Pryke JS, Samways MJ (2022) Identifying managerial legacies within conservation corridors using remote sensing and grasshoppers as bioindicators. Ecological Applications 32: e02496. https://doi.org/10.1002/eap.2496

Tiokeng B, Ngougni ML, Nguetsop VF, Momo Solefack MC, Zapfack L (2020) Sacred forests in the Western highlands Cameroon: interest in biodiversity conservation. European Scientific Journal 16: 234–256. https://doi.org/10.19044/esj.2020.v16n36p234

Uchida K, Ushimaru A (2014) Biodiversity declines due to abandonment and intensification of agricultural lands: patterns and mechanisms. Ecological Monographs 84: 637–658. https://doi.org/10.1890/13-2170.1

Unsicker SB, Franzke A, Specht J, Kohler G, Linz J, Renker C, Stein C, Weisser WW (2010) Plant species richness in montane grasslands affects the fitness of a generalist grasshopper species. Ecology 91: 1083–1091. https://doi.org/10.1890/09-0402.1

Uvarov BP (1923) Some new short-horned grasshoppers from East Africa. Annals and Magazine of Natural History 11: 675–689. https://doi.org/10.1080/00222932308632908

von Charpentier T (1825) De Orthopteris Europaeis. In Horae entomologicae, adjectis tabulis novem coloratis. Apud A. Gosohorsky, Wroclaw, Poland. https://doi.org/10.5962/bhl.title.5530

Walker F (1870) In Catalogue of the Specimens of Dermaptera Saltatoria in the Collection of the British Museum, London, United Kingdom.

Walker F (1871) Catalogue of the Specimens of Dermaptera Saltatoria in the Collection of the British Museum: Vol. Supplement. London, United Kingdom.

Wandji AC, Kekeunou S, Mbadjoun-Nzike M, Simeu-Noutchoum A, Fomena A (2019) Grasshopper (Orthoptera: Acrididea) assemblages in forests and savanna areas in Center, West and South-west regions of Cameroon. Journal of Insect Biodiversity 12: 17–32. https://doi.org/10.12976/jib/2019.12.1.3

Yetchom-Fondjo JA, Kekeunou S, Kenne M, Missoup AD, Sheng-Quan X (2020) Diversity, abundance and distribution of grasshopper species (Orthoptera: Acrididea) in three different types of vegetation with different levels of anthropogenic disturbances in the Littoral Region of Cameroon. Journal of Insect Biodiversity 14: 16–33.

Yoshioka A, Kadoya T, Suda S, Washitani I (2010) Impacts of weeping lovegrass (*Eragrostis curvula*) invasion on native grasshoppers: responses of habitat generalist and specialist species. Biological Invasions 12: 531–539. https://doi.org/10.1007/s10530-009-9456-x

Zang Z, Zeng Y, Wang D, Shi F, Dong Y, Liu N, Liang Y (2022) Species-Abundance Distribution Patterns of Plant Communities in the Gurbantünggüt Desert, China. Sustainability 14: 12957. https://doi.org/10.3390/su142012957

Zwets JA, Sterck EHM, Verweij PA, Maisels F, van der Waarde J, Geelen EAM, Tchoumba GB, Donfouet-Zebaze HF, van Kuijk M (2024) FSC-certified forest management benefits large mammals compared to non-FSC. Nature 628: 563–568. https://doi.org/10.1038/s41586-024-07257-8

Appendix 1

Table A1. Absolute abundance, occurrence, and sampling effort of grasshopper species across vegetation types and seasons in Bangou district. Values are shown as absolute abundance (occurrence); Chao-1 indicates estimated species richness (sampling effort); Taxa S represents observed species richness.

Family, Subfamily, Species	Crop field	Forest	Fallowland	Bare soil	Total
Acrididae MacLeay, 1821					
Acridinae MacLeay, 1821					
Acrida bicolor (Thunberg, 1815)	8(3)	0(0)	12(5)	2(1)	22(9)
Acrida sulphuripennis (Gerstaecker, 1869)	3(2)	0(0)	4(2)	3(2)	10(6)
Cannula gracilis (Burmeister, 1838)	0(0)	0(0)	10(5)	0(0)	10(5)
Coryphosima stenoptera (Schaum, 1853)	105(12)	0(0)	228(11)	21(6)	354(29)
Gymnobothrus cruciatus Bolívar, 1889	9(4)	1(1)	12(6)	2(2)	24(13)
Machaeridia bilineata Stål, 1873	0(0)	0(0)	23(7)	0(0)	23(7)
Odontomelus kamerunensis Ramme, 1929	0(0)	10(3)	2(1)	0(0)	12(4)
Orthochtha nigricornis (Karsch, 1893)	28(4)	0(0)	59(8)	4(2)	91(14)
Parga cyanoptera Uvarov, 1926	1(1)	0(0)	13(5)	0(0)	14(6)
Roduniella insipida (Karsch, 1896)	46(10)	0(0)	37(8)	8(3)	91(21)
Catantopinae Brunner von Wattenwyl, 1893					
Abisares viridipennis (Burmeister, 1838)	2(2)	0(0)	0(0)	0(0)	2(2)
Anthermus sp.	0(0)	0(0)	4(1)	1(1)	5(2)
Catantops melanostictus Schaum, 1853	33(9)	4(2)	7(3)	12(6)	56(20)
Criotocatantops pulchripes (Karny, 1917)	0(0)	0(0)	1(1)	0(0)	1(1)
Crobylostenus sp.	1(1)	0(0)	3(2)	0(0)	4(3)

Family, Subfamily, Species	Crop field	Forest	Fallowland	Bare soil	Total
Exopropacris rehni (Sjöstedt, 1923)	0(0)	0(0)	1(1)	0(0)	1(1)
Hadrolecocatantops glauningi (Ramme, 1929)	22(5)	1(1)	8(3)	0(0)	31(9)
Phaeocatantops signatus (Karsch, 1891)	8(3)	3(1)	0(0)	0(0)	11(4)
Coptacrinae Brunner von Wattenwyl, 1893					
Epistaurus bolivari Karny, 1907	13(6)	0(0)	6(4)	5(3)	24(13)
Eucoptacra anguliflava (Karsch, 1893)	2(1)	0(0)	15(6)	2(1)	19(8)
Eucoptacra exigua Bolívar, 1912	0(0)	0(0)	16(5)	0(0)	16(5)
Eucoptacra gowdeyi Uvarov, 1923	0(0)	0(0)	8(1)	0(0)	8(1)
Parepistaurus sp.	0(0)	13(9)	0(0)	0(0)	13(9)
Cyrtacanthacridinae Kirby, 1910					
Acanthacris ruficornis (Fabricius, 1787)	8(4)	0(0)	2(2)	0(0)	10(6)
Cyrtacanthacris aeruginosa (Stoll, 1813)	3(3)	0(0)	1(1)	0(0)	4(4)
Cyrtacanthacris tatarica (Linnaeus, 1758)	1(1)	0(0)	2(1)	0(0)	3(2)
Ornithacris cyanea (Stoll, 1813)	0(0)	0(0)	1(1)	0(0)	1(1)
Calliptaminae Jacobson, 1905					
Acorypha sp.	0(0)	0(0)	10(6)	0(0)	10(6)
Eyprepocnemidinae Brunner von Wattenwyl, 1893					
Eyprepocnemis noxia Dirsh, 1950	1(1)	0(0)	14(5)	0(0)	15(6)
Eyprepocnemis plorans (von Charpentier, 1825)	21(9)	0(0)	2(2)	2(2)	25(13)
Heteracris guineensis (Krauss, 1890)	1(1)	1(1)	1(1)	0(0)	3(3)
Oedipodinae Walker, 1871					
Gastrimargus africanus (de Saussure, 1888)	1(1)	0(0)	2(2)	0(0)	3(3)
Heteropternis couloniana (de Saussure, 1884)	35(6)	0(0)	3(2)	1(1)	39(9)
Heteropternis thoracica (Walker, 1870)	46(11)	0(0)	8(4)	1(1)	55(16)
Morphacris fasciata (Thunberg, 1815)	5(4)	0(0)	1(1)	4(2)	10(7)
Trilophidia conturbata (Walker, 1870)	13(8)	0(0)	11(3)	8(5)	32(16)
Trilophidia repleta (Walker, 1870)	1(1)	0(0)	11(6)	1(1)	13(8)
Oxyinae Brunner von Wattenwyl, 1893					
Parapterotiltus minimoides Oumarou-Ngoute & Rowell, 2024	0(0)	6(3)	0(0)	0(0)	6(3)
Pterotiltus coeruleocephalus Bolívar, 1905	1(1)	8(5)	0(0)	0(0)	9(6)
Thericleidae Burr, 1899					
Thericleinae Burr, 1899					
Thericles sp.	0(0)	5(4)	0(0)	0(0)	5(4)
Pyrgomorphidae Brunner von Wattenwyl, 1874					
Pyrgomorphinae Brunner von Wattenwyl, 1874					
Atractomorpha accutipennis (Guérin-Méneville, 1844)	1(1)	0(0)	5(3)	2(1)	8(5)
Chrotogonus homalodemus (Blanchard, 1836)	10(4)	0(0)	1(1)	37(8)	48(13)
Dictyophorus griseus (Reiche & Fairmaire, 1849)	0(0)	0(0)	7(4)	3(2)	10(6)
Occidentosphena uvarovi (Rehn, 1942)	1(1)	0(0)	0(0)	0(0)	1(1)
Parapetasia rammei Sjöstedt, 1923	0(0)	1(1)	0(0)	0(0)	1(1)
Pyrgomorpha vignaudii (Guérin-Méneville, 1847)	12(5)	0(0)	5(3)	2(2)	19(10)
Taphronota calliparea (Schaum, 1853)	5(3)	2(2)	0(0)	0(0)	7(5)
Zonocerus variegatus (Linnaeus, 1758)	2(2)	0(0)	5(3)	5(3)	12(8)
Dry season	167	30	178	45	420
Rainy season	282	25	383	81	771
Total	449(12)	55(12)	561(12)	126(12)	1191(48)
Taxa S	33	12	39	21	48
Chao-1	44(75%)	15(80%)	42(92%)	22(95%)	53(90%)

Table A2. Similarity Percentage (SIMPER) of grasshopper species between samples across habitats. Av. Dissim.: Average dissimilarity (the mean contribution of a species to the overall dissimilarity among the four habitats); Contrib. %: Contribution percentage (the percentage contribution of a species to the total dissimilarity among the four habitats); Cumulative %: Cumulative sum of the percentage contributions of the listed species; Mean Crop field, Mean Forest, Mean Fallowland, Mean Bare soil: Average abundance of each species in each habitat, reflecting its contribution to dissimilarity among habitats.

Taxa	Av. dissim.	Contrib. %	Cumulative %	Mean Crop field	Mean Forest	Mean Fallowland	Mean Bare soil
Coryphosima stenoptera	21.07	23.49	23.49	8.75	0	19.00	1.75
Chrotogonus homalodemus	5.89	6.57	30.06	0.83	0	0.08	3.08
Orthochtha nigricornis	5.67	6.33	36.39	2.33	0	4.92	0.33
Roduniella insipida	5.50	6.13	42.52	3.83	0	3.08	0.66
Heteropternis thoracica	4.08	4.55	47.08	3.83	0	0.66	0.08
Catantops melanostictus	4.03	4.49	51.58	2.75	0.33	0.58	1.00
Heteropternis couloniana	2.99	3.33	54.91	2.92	0	0.25	0.08
Parepistaurus sp.	2.64	2.94	57.86	0	1.08	0	0
Trilophidia conturbata	2.41	2.69	60.54	1.08	0	0.91	0.66
Hadrolecocatantops glauningi	2.13	2.38	62.92	1.83	0.08	0.66	0
Machaeridia bilineata	2.07	2.31	65.24	0	0	1.92	0
Eyprepocnemis plorans	2.01	2.24	67.48	1.75	0	0.16	0.16
Epistaurus bolivari	1.84	2.05	69.53	1.08	0	0.50	0.41
Gymnobothrus cruciatus	1.75	1.95	71.49	0.75	0.08	1.00	0.16
Pterotiltus coeruleocephalus	1.74	1.94	7.,44	0.08	0.66	0	0
Acrida bicolor	1.58	1.76	75.20	0.66	0	1.00	0.16
Eucoptacra anguliflava	1.47	1.64	76.84	0.16	0	1.25	0.16
Odontomelus kamerunensis	1.46	1.63	78.47	0	0.83	0.16	0
Pyrgomorpha vignaudii	1.44	1.60	80.08	1.00	0	0.41	0.16
Parapterotiltus minimoides	1.19	1.33	81.41	0	0.50	0	0
Eucoptacra exigua	1.16	1.29	82.71	0	0	1.33	0
Parga cyanoptera	1.12	1.25	83.96	0.08	0	1.08	0
Eyprepocnemis noxia	1.07	1.19	85.16	0.08	0	1.17	0
Thericles sp.	1.04	1.16	86.33	0	0.41	0	0
Zonocerus variegatus	1.02	1.14	87.48	0.16	0	0.41	0.41
The 23 remaining species	11.23	12.52	100	3.41	0	6.16	1.16